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SITE SURVEY OF THE SOUTHERN PORTION OF THE SAN JUAN SEAMOUNT

By

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## SITE SURVEY OF THE SOUTHERN PORTION OF THE SAN JUAN SEAMOUNT

Technical Note N- 1018

56-003

by

John B. Ciani and Joseph R. Padilla

## ABSTRACT

As coparticipants with the Naval Underseas Warfare Center, San Diego, in a program to install the transmission end of an inter-seamount acoustic range, NCEL conducted a site survey of the southern portion of the San Juan Seamount. A detailed topographic chart was developed for the area, underwater photographs were taken and water and sea floor samples were collected and analyzed. It was found that the surface of the area is irregular and rough; it is volcanic in origin, consisting of vesicular basalt bearing a ferro-manganese coating. The current at depth is judged to be slight - no greater than 1 knot. It is anticipated that unless the biological and chemical environment is materially changed locally by acoustic energy or heat emission from the operation of the installed equipment, no more than normal corrosion or fouling will result.

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## INTRODUCTION

### Background

It was planned that NCEL participate with the Naval Underseas Warfare Center in San Diego to install the transmission end of an underwater acoustic range for long-term investigations of submarine acoustics.

The southern part (below 33°-02') of the San Juan Seamount (33°N, 121°W) was chosen as the site of the transmission array with receivers on another seamount approximately 300 miles away. The major criteria for the selection of these sites were the acoustic properties of the area.

The heart of the acoustic transmission facility is to be an array of four acoustic projectors each of a different frequency. The power for the projectors will come from a radioisotope target source generator, which maintains a charge on a bank of nickel-cadmium batteries. The batteries intermittently activate the projectors through an electronic system. The plan is to mount the power source in a structure resting on the ocean bottom and buoy the projectors above it.

NCEL undertook a site survey for acquisition of information to properly design the facility, including recovery systems, and appurtenances. The methods of this survey and the results are related here.

### Scope

The site survey was intended to determine the physical and chemical nature of the ocean bottom environment at the selected site. Topographic information was required as well as water chemistry and ocean bottom characteristics.

### Previous Investigations

Figure 1 shows the location of the San Juan Seamount relative to the Southern California Coast. It is situated approximately 25-30 miles west of the generally accepted shelf break, on the continental slope. Figure 2 is taken from a currently used chart (C&GS 1306N19) compiled by the Coast and Geodetic Survey, from data taken prior to 1937.<sup>1</sup> This chart shows the general SW-NE trend of the Seamount topography and the relatively steep slopes. The area covered by the NCEL Site Survey is outlined in Figure 2.

Until only recently, most of the work at the San Juan Seamount had been done by Emery and Shepard. Figure 3 shows the bottom contours

established by a topographic survey conducted aboard the vessel E. W. SCRIPPS by these men.<sup>2</sup> The San Juan Seamount was found to be a ridge containing a series of sharp summits. Small samples of material laboriously dredged from the southeast side of the seamount were described as basaltic rock.

Shepard and Emery reflected on the origin of the San Juan Seamount. They pondered over whether it was a fault block or a volcano, presenting arguments for both interpretations.

In 1945 Emery and Shepard stated that the San Juan Seamount probably was a volcanic cone.<sup>3</sup> They described material dredged at 500 to 900 fathoms northeast of the site of the present NCEL survey as angular brown and dark gray basalt or plagioclase porphyry. Some of the samples were weathered and others freshly fractured.

Emery in 1960 once again alluded to the volcanic appearance of the San Juan Seamount.<sup>4</sup> Additional evidence of the volcanic origins of the seamount were obtained in 1967 when the Naval Oceanographic Office conducted a bathymetric and magnetic field investigation of the southern portion of the San Juan Seamount.<sup>5</sup> Magnetic intensity measurements indicate a basaltic mass runs from the seamount eastward under the continental shelf. This NAVOCEANO investigation was a preliminary step of the planned interseamount acoustic range which prompted the work of this report. Figure 4 is taken from the report of the NAVOCEANO investigation.<sup>5</sup>

## PROCEDURES

### General

The NCEL San Juan Seamount site survey was conducted on two cruises aboard the oceanographic research vessel USNS CHARLES H. DAVIS (T-AGOR-5). The first cruise was made during 26-30 July 1967 and the second during 12-16 November 1967. Data collection was handled by NCEL personnel with help from the crew of the vessel and the Naval Oceanographic Office personnel aboard.

### Positioning

A radio location system (LORAC) was used for accurate navigation and positioning during data collection. This precision system is operated mainly for use in missile tracking and recovery in the Naval Pacific Missile Range (PMR) which includes the San Juan Seamount. The system uses three continuous radio wave stations and a reference station. It employs the principle of phase comparison of radio signals to provide a grid of hyperbolic lines. A shipboard receiving and phase measuring unit determines the position of the ship on the hyperbolic grid. Computer generated charts of this grid are superimposed on standard navigation charts providing a geographical comparison.<sup>6</sup>

An estimate of the total random errors of the PMR LORAC system at the San Juan Seamount was made during a calibration of the network in 1965, and a maximum value of  $\pm 30$  feet was established. The resolution of the system is 0.01 of a lane. Although the lane width at the area of concern is approximately 1,000 feet, the lanes intersect at an angle of 34 degrees, which yields roughly 3,500 feet maximum lane difference or  $\pm 35$  feet resolution. Other sources of error exist but these may be lumped conservatively into a total of  $\pm 90$  feet. The root mean square of these three errors, which are assumed to include all system errors, is  $\pm 100$  feet. Problems caused by sky wave interference and failures of lane identification equipment at the transmission station during the cruises made post-cruise adjustments to the accumulated positioning data necessary. With these adjustments and the human factors involved, the accuracy of the positioning may be conservatively assumed to be  $\pm 200$  feet.

#### Bathymetry

The depth to the bottom was determined during the July cruise with a precision depth recorder (PDR), which was set on the 0 to 600 fathom scale for the entire cruise. On the second cruise, in November, the depth was recorded by a precision graphic recorder (PGR), which was set on the 300 to 600 fathom scale for the cruise duration. It is estimated that the accuracy of the PDR on the scale noted was  $\pm 3$  fathoms and that of the PGR on the scale noted was  $\pm 2$  fathoms. Both instruments were used in connection with the AN/UQN-1E Sonar system, which on the USNS DAVIS has a transducer emitting a 30-degree sonar cone. On the bottom at a water depth of 370 fathoms, this cone covers a circular area approximately 1,200 feet in diameter, consequently the indicated depth is the first return from the area. The accuracy of the topographic data therefore is less for the rugged seamount than it would be for gently sloping areas.

The observed depths were corrected for the location of the transducer below the water level. No correction was applied for discrepancies in true depth due to acoustic distortions or tidal variations. This was because the survey was intended to produce a chart to be used for emplacing the required equipment on the bottom using conventional echo sounding equipment, which has similar errors.

#### Bottom Sampling

During the July cruise, grab sampling of the bottom was attempted with the NCEL grab sampler, but nothing was retrieved. Pipe and triangular prism dredges were employed and recovered some rock. Dredging was so difficult that it seemed to verify the opinions from the literature that the surface of the seamount is very irregular. Therefore, a piston corer was not employed because it appeared likely that the area is mostly rock with little if any sediment.

The rock samples were visually inspected by a geologist for general classification. The coating was examined in an x-ray spectrograph to determine its composition.<sup>8</sup>

#### Water Sampling and Analysis

During the November cruise, two water-sampling casts were made using messenger-actuated Nansen bottles and attached precision deep-sea reversing thermometers. The first cast sampled the bottom 150 feet of the water column, and the second cast sampled the entire water column. The position of the sampling bottles relative to the bottom was determined from the wire length (corrected for wire angle) between the sampling bottles and a 150-pound sinker. Contact of the sinker with the bottom was sensed by a load cell attached to the sheave passing the hydrographic wire.

The readings of the thermometers were corrected for instrument errors and pressure effects. The thermometer depths were determined using standard Naval Oceanographic Office procedures and the accepted depth calculated graphically using the L-Z method.<sup>9</sup>

Salinity values were determined at the Laboratory by means of an inductive salinometer, with Copenhagen water used as a standard.

Dissolved oxygen values were determined aboard ship by the Winkler method as described by Barnes.<sup>10</sup> Hydrogen ion concentration (pH) was determined aboard the ship with an expanded-scale pH meter, with a 7.0 pH buffer used as a standard and the temperature and pressure corrected to give the in-situ pH.

Oxidation reduction potential (Eh) values were determined by means of an expanded-scale pH meter with a platinum electrode by measuring the electrode potential in millivolts.

#### Photography

An underwater 35mm camera was lowered to take photographs of the site during the November cruise. A strobe flash with a battery pack was periodically activated by a clock to serve as a light source.

#### RESULTS

##### Topographic Chart

Figure 5 shows the topographic features of the southern portion of the San Juan Seamount as determined by this site survey.

After the July cruise and examination of the resulting preliminary topographic chart, it was decided that the two southernmost rises, 350 and 390 fathoms, constituted likely prospective sites for the required installation. Consequently, the November cruise concentrated on these areas. Generally the contours in 50-fathom increments were taken from

the data of the July cruise and found to be in agreement with the data of the November cruise. The detail above the 400-fathom contour was taken almost entirely from the November cruise.

#### Photographs

Figures 6 through 11 were taken at assorted locations on the seamount and were selected to show the range of the bottom conditions.

Figures 6 and 7 show the very rough bottom which is characterized by many photographs taken at various locations on the seamount. Other areas are relatively smooth and platelike in appearance as shown by Figures 8 and 9. Figure 10 shows a rare occurrence of sediment on the seamount. Figure 11 shows various forms of animal life on the seamount including sponges and gorgonians.

#### Rock Samples

Figure 12 shows two rocks (from  $33^{\circ}00'50''N$ ,  $120^{\circ}59'40''W$ ) which are representative of those dredged from the top of the seamount. The rocks appear to be vesicular basalt. The 1/8-inch thick coating was found to be predominantly iron and manganese with some zinc, cobalt and strontium and small amounts of molybdenum and zirconium. Dredging operations were very difficult because of the apparent catching of the dredge on the bottom. Some of the rocks brought to the surface appeared freshly fractured and angular while others were rounded and uniformly colored.

#### Water Information

Table 1 and Figure 13 give the results of the water analysis.

#### DISCUSSION

It appears from a comparison of the previous topographic charts with the chart developed from the data gathered by this site survey that some discrepancies exist. However, areas of agreement with both prior topographic attempts are also to be found.

The Shepard and Emery chart checks very well at the crest, but the notable peak at  $33^{\circ}00'30''N$ ,  $121^{\circ}00'45''W$  was not portrayed. The lower contours on this 1941 chart appear directly to the east (occasionally as much as 2,000 feet east) of those on the new chart. However, the general shape of the seamount as presented in the Shepard and Emery chart and in the NCEL chart agree surprisingly well.

A comparison of the shapes of the seamount as depicted by Thomas (NAVOCEANO) and by this survey shows that they are very similar. Thomas also detected the rise that Shepard and Emery missed. However, the entire NAVOCEANO chart appears north, northwest of the new chart.

Table 1. Water Sample Data.

Depth of Water Sample (fathoms)	Temperature (°C)	Salinity (parts per 1,000)	Dissolved Oxygen Content (milliliters per liter)			Hydrogen Ion Concentration (pH)	Oxidation Reduction Potential (Eh) (millivolts)
			Dissolved Oxygen Content (milliliters per liter)	Hydrogen Ion Concentration (pH)	Oxidation Reduction Potential (Eh) (millivolts)		
0	19.000	33.527	5.747	8.126	+162		
46	11.908	33.222	5.629	8.187	154		
<u>80</u>	<u>9.321</u>	<u>33.716</u>	<u>3.703</u>	<u>7.987</u>	<u>156</u>		
97	8.893	33.920	3.215	7.965	152		
150	7.200	34.098	2.233	7.894	150		
185	6.520	34.163	1.407	7.816	148		
220	6.284	34.239	0.723	7.761	146		
225	6.015	34.257	0.566	7.708	139		
290	5.765	34.291	0.401	7.708	140		
325	5.302	34.364	0.370	7.722	133		
340	4.926	34.383	0.307	7.644	145		
<u>344</u>	<u>4.895</u>	<u>34.289</u>	<u>0.307</u>	<u>7.663</u>	<u>147</u>		
347	4.828	34.396	0.786	7.634	147		
<u>350</u>	<u>4.813</u>	<u>34.410</u>	<u>0.377</u>	<u>7.613</u>	<u>147</u>		
<u>352</u>	<u>4.794</u>	<u>34.426</u>	<u>0.280</u>	<u>7.585</u>	<u>147</u>		
<u>356</u>	<u>4.747</u>	<u>34.417</u>	<u>0.280</u>	<u>7.607</u>	<u>167</u>		
<u>358</u>	<u>4.758</u>	<u>34.414</u>	<u>0.280</u>	<u>7.677</u>	<u>154</u>		
<u>360</u>	<u>4.923</u>	<u>34.423</u>	<u>0.322</u>	<u>7.714</u>	<u>136</u>		
<u>362</u>	<u>4.746</u>	<u>34.427</u>	<u>0.354</u>	<u>7.676</u>	<u>161</u>		
<u>364</u>	<u>4.706</u>	<u>34.429</u>	<u>0.472</u>	<u>7.654</u>	<u>151</u>		
<u>370</u>	<u>4.717</u>	<u>34.428</u>	<u>0.472</u>	<u>7.591</u>	<u>140</u>		
371	Bottom						

Note: Underscored depths are from first cast at  $33^{\circ}01'10''\text{N}$ ,  $120^{\circ}59'50''\text{W}$ ;  
Other depths are from second cast at  $33^{\circ}01'10''\text{N}$ ,  $121^{\circ}00'00''\text{W}$ .

Occasionally there is as much as 3,000 feet of lateral separation between the contours of the chart by Thomas and those of the chart of this site survey.

The conclusion of previous work on the San Juan Seamount that it is a volcanic mass rather than a fault block is confirmed by this site survey. The appearance of the bottom in this area and the geologic and chemical analyses of the recovered material bear out this conclusion with little doubt. The main rock is rather obviously volcanic, coated with a ferro-manganese crust.

Although attempts were made to measure the currents in the area, the loss of instruments precluded this data acquisition. An estimated maximum current of 1 knot should be used in the installation design. This is a conservative estimate because the seamount is below the mixed layer. The literature records a maximum current of approximately 0.4 knot at a depth of 650 feet.<sup>11</sup> The fact that the very top of the seamount is at the point of minimum dissolved oxygen is further evidence that insufficient current exists in the area to bring in oxygen to replace that consumed in the breakdown of detritus. The near absence of sediment can probably be attributed to the steepness of the slopes, which sometimes exceed 20 degrees, rather than to the action of strong currents.

Although some evidence of marine organisms at the site is shown in the photographs, and some organisms were included with the material recovered in dredging, it is unlikely that the area is rich in animal life. The severity of the environment (steep slopes, lack of organic sediments, low oxygen content, and low temperature) would limit biological activity at the site.

#### FINDINGS

The most notable feature of the southern portion of the San Juan Seamount is the highly irregular topography especially on the rise to 350 fathoms at 33°00'30"N, 121°00'45"W. This is very unfortunate because this area was to serve as the platform for the power system for the acoustic projectors in the range transmission facility. As a result, a very complex installation design was required to facilitate the eventual retrieval of the transmission system, which includes very expensive electronic components and radioisotope power generators.

It is also of concern that the seamount is very rough with little or no sediment. The concern is not for the strength of the area as a foundation material, but rather for the stability of a bottom laid object and the danger of damage to it. The rocks appear either very sharp or very platy and smooth. Consequently, the bottom-mounted structure was designed with a 1-inch steel plate floor to protect the power system and with protruding corner members to provide stability.

The low oxygen content and moderate salinity shown by the water data is an advantage with respect to the corrosion of the equipment

during its stay on the bottom. The low level of biological activity which is expected should minimize fouling of the installed equipment.

#### CONCLUSIONS

1. The combination of the Naval Pacific Missile Range LORAC radio location system and the USNS DAVIS AN/UQN sonar produced a topographic chart that defines within certain limits of accuracy the relief of this seamount.
2. The San Juan Seamount is volcanic in origin, consisting of vesicular basalt coated with a ferro-manganese crust resembling manganese nodules in chemical composition.
3. This seamount is very irregular and rough, consequently a very complex installation design is required for the range transmission facility.
4. The current is very slight, adjudged less than 1 knot.
5. Neither biological fouling nor corrosion appear to present unusual problems at this site. Actions of the installed equipment, such as the heat from the radioisotope generator, could however significantly change the environment and consequently its corrosive or biological potential.

#### ACKNOWLEDGEMENTS

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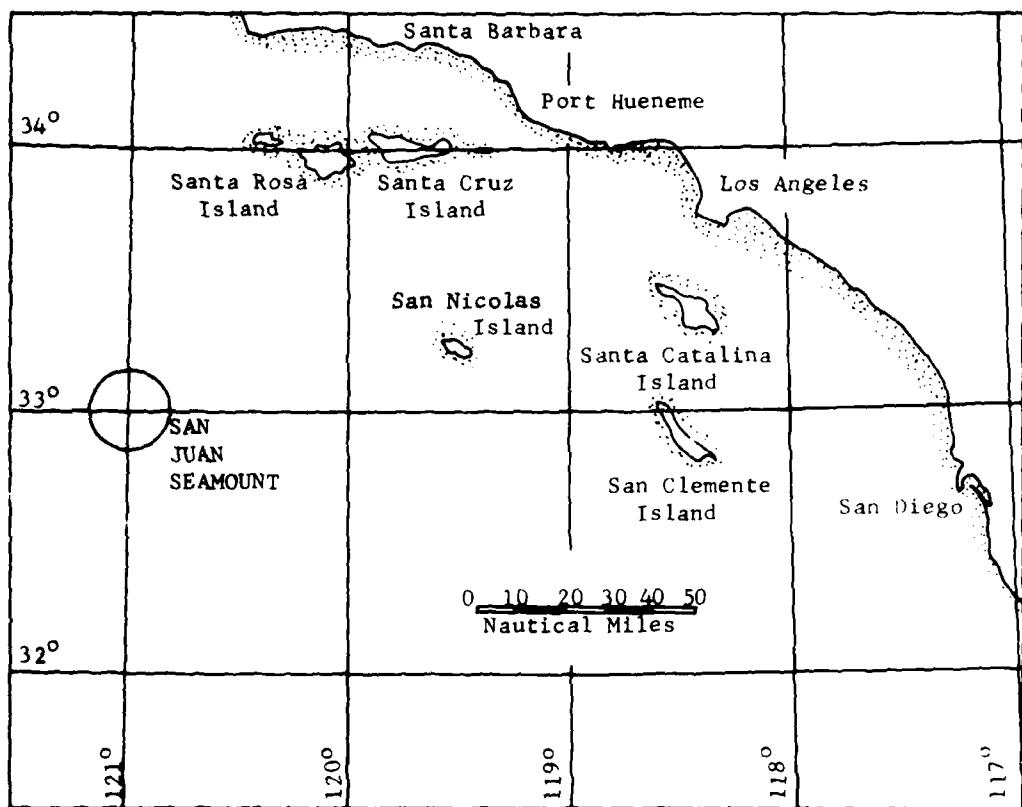


Figure 1  
Vicinity Chart of San Juan Seamount

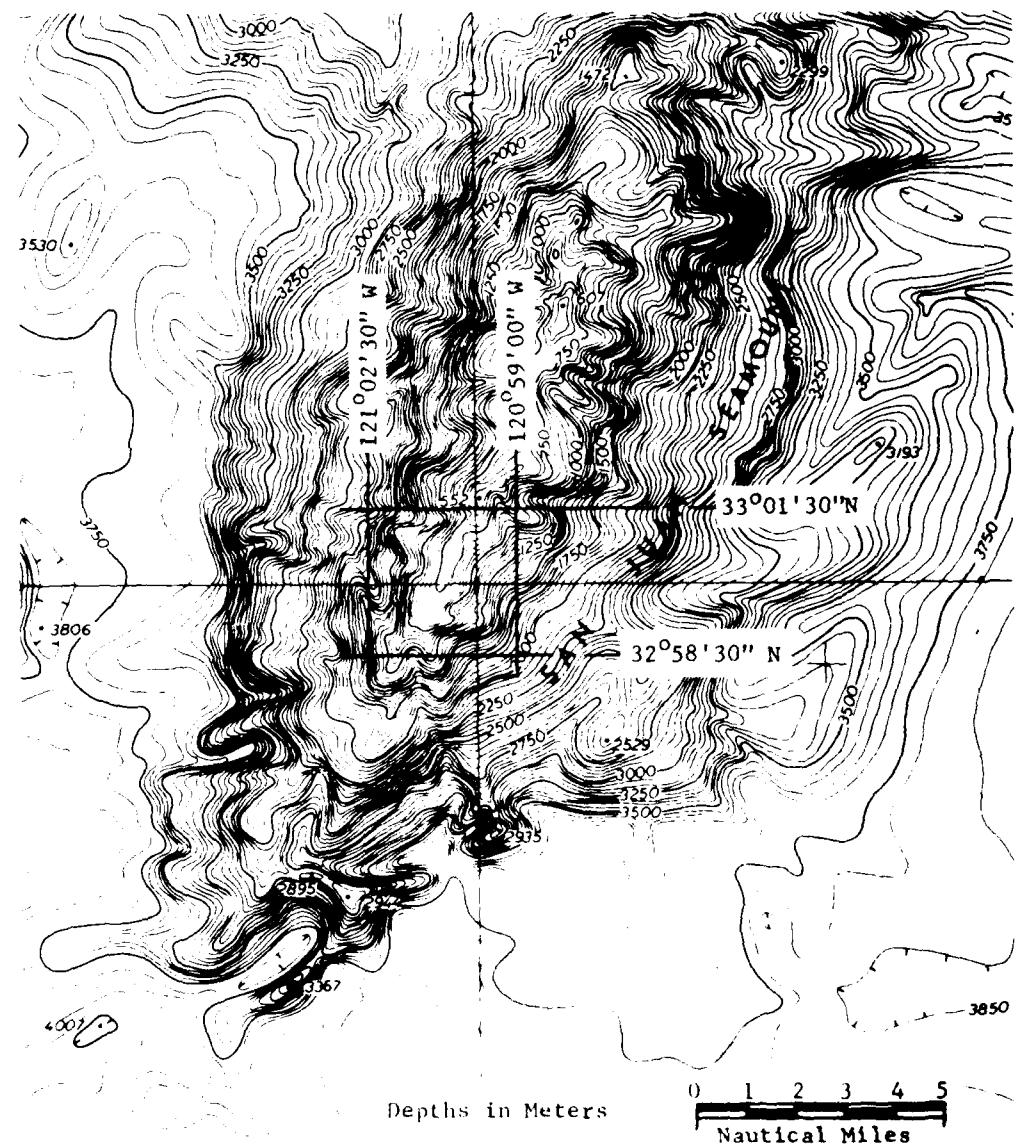


Figure 2

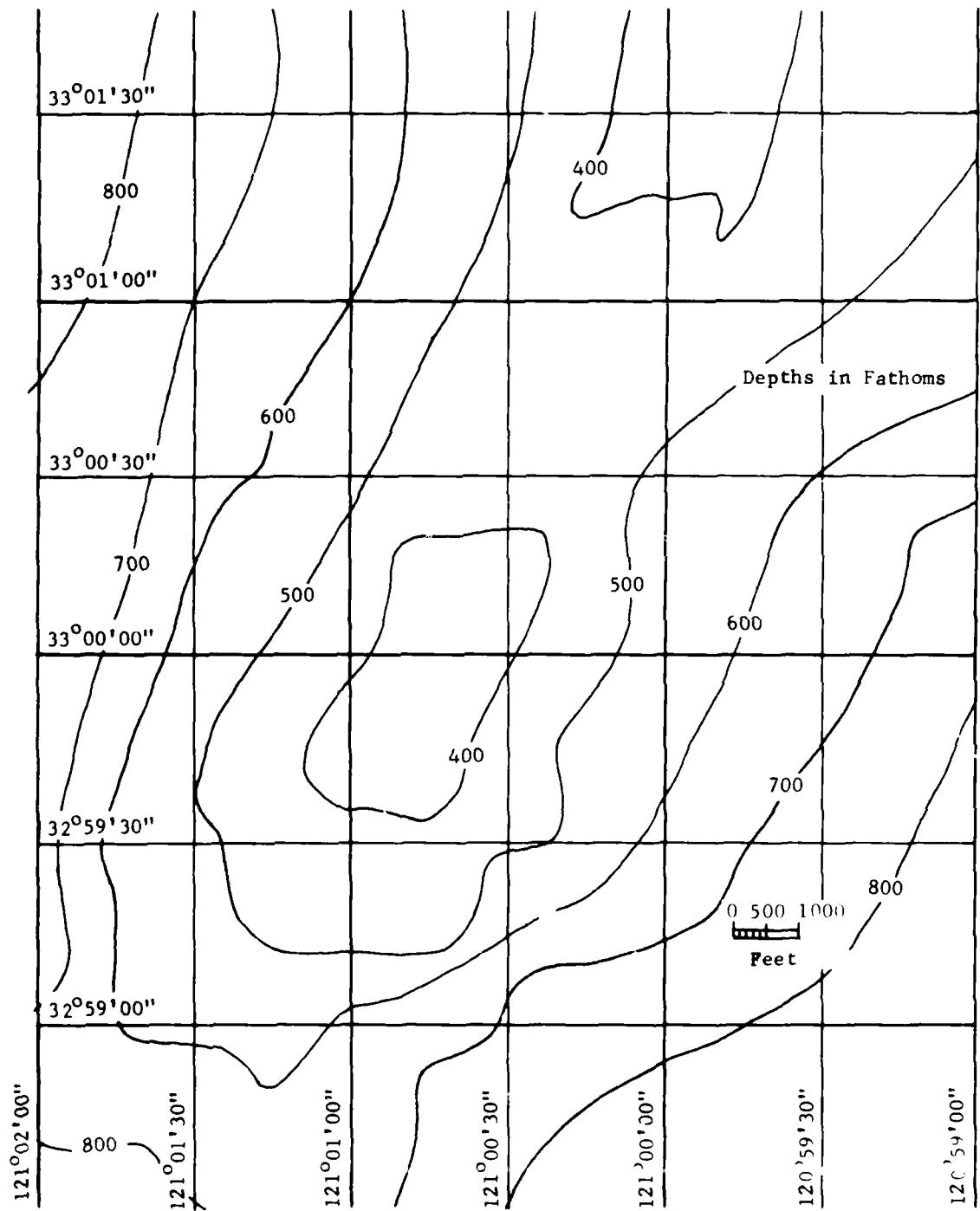


Figure 3

San Juan Seamount, Southern Portion, from Shepard and Emery

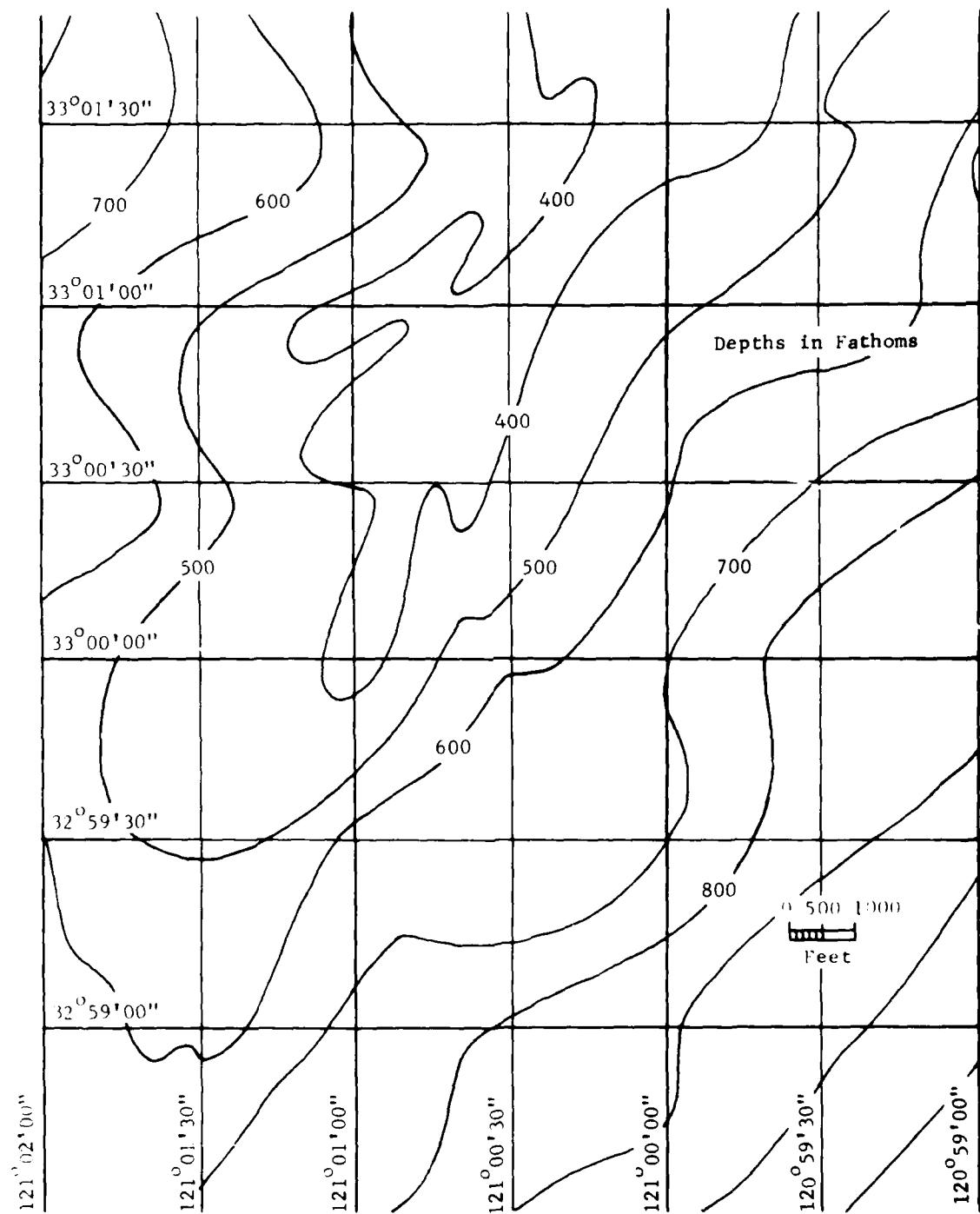


Figure 4

San Juan Seamount, Southern Portion, from Thomas

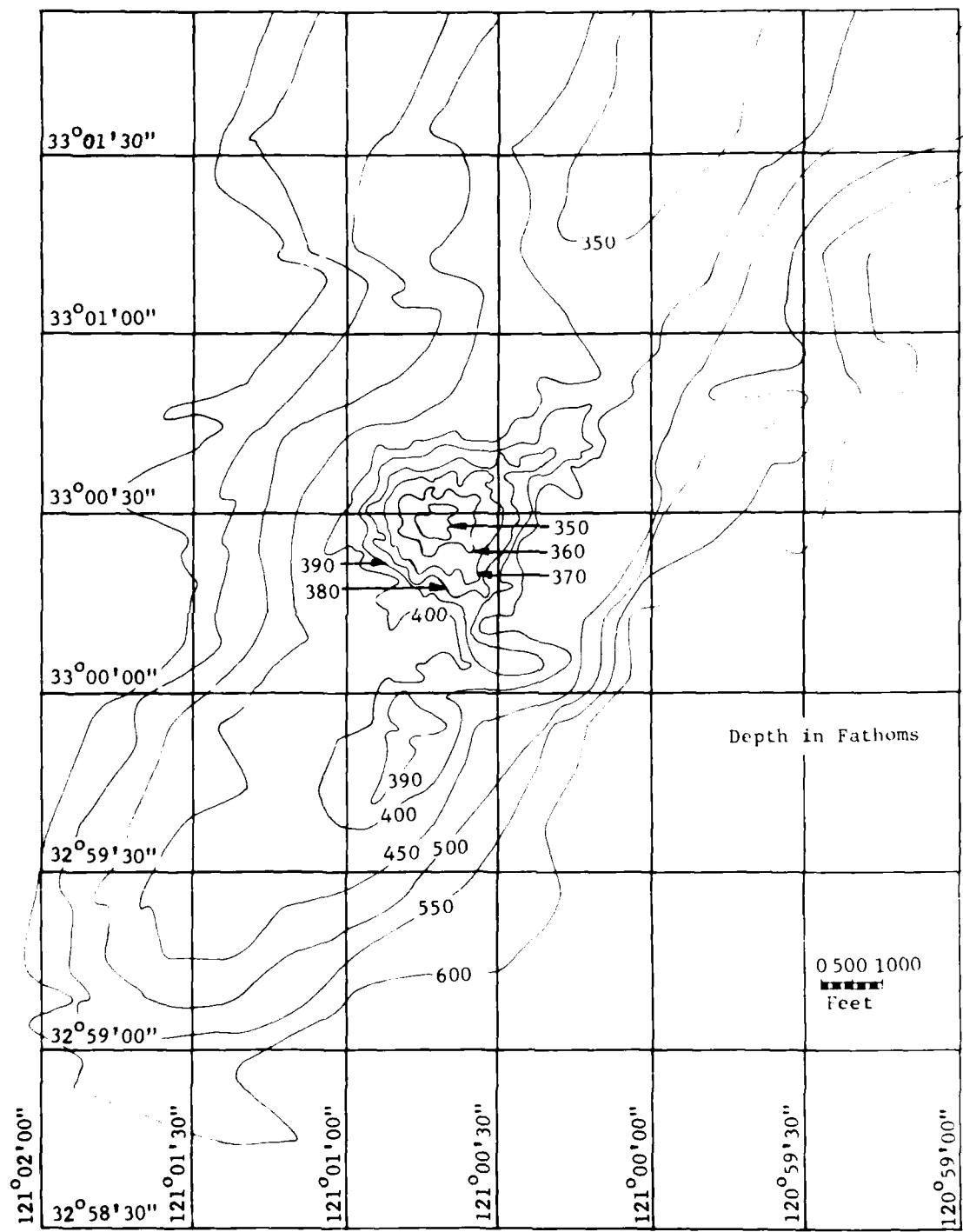


Figure 5

San Juan Seamount, Southern Portion, Topographic Chart



Figure 6. Rough Seamount Surface at  
33° 01' 40" North, 120° 59' 50" West, 340 Fathoms



Figure 7 Rough Surface of Seamount at  
33° 00' 40" North, 121° 00' 00" West, 440 Fathoms



Figure 8 Smooth Plate-like Seamount Surface at  
33°01'50" North, 120°59'40" West, 350 Fathoms

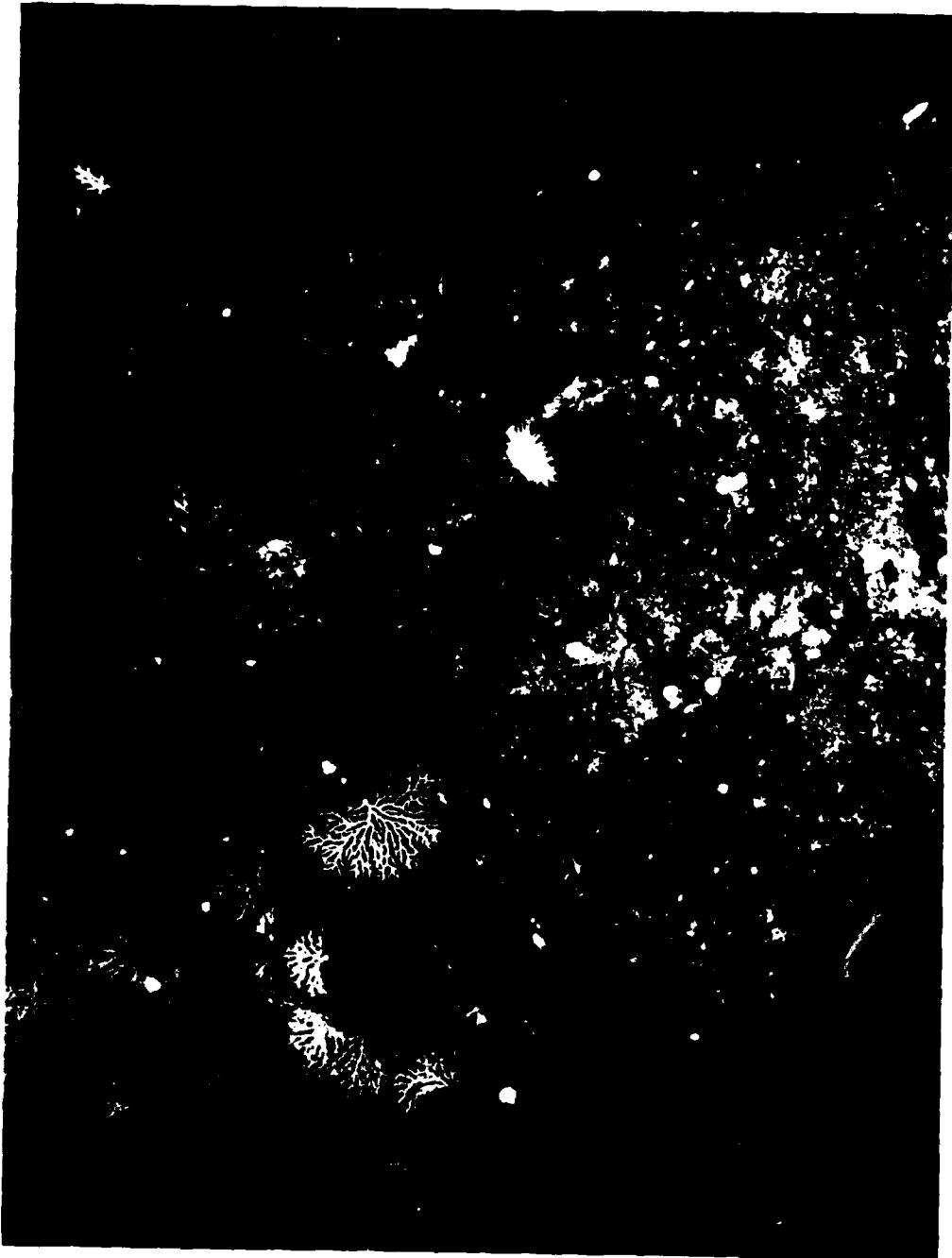


Figure 9 Smooth Platelike Surface of Seamount at  
33° 00' 50" North, 120° 59' 50" West, 480 Fathoms



Figure 10 Small Deposits of Sediment at  
33°01'40" North, 121°00'00" West, 330 Fathoms



Figure 11. Animal Life on Seamount at  
33° 02' 00" North, 120° 59' 30" West, 360 Fathoms

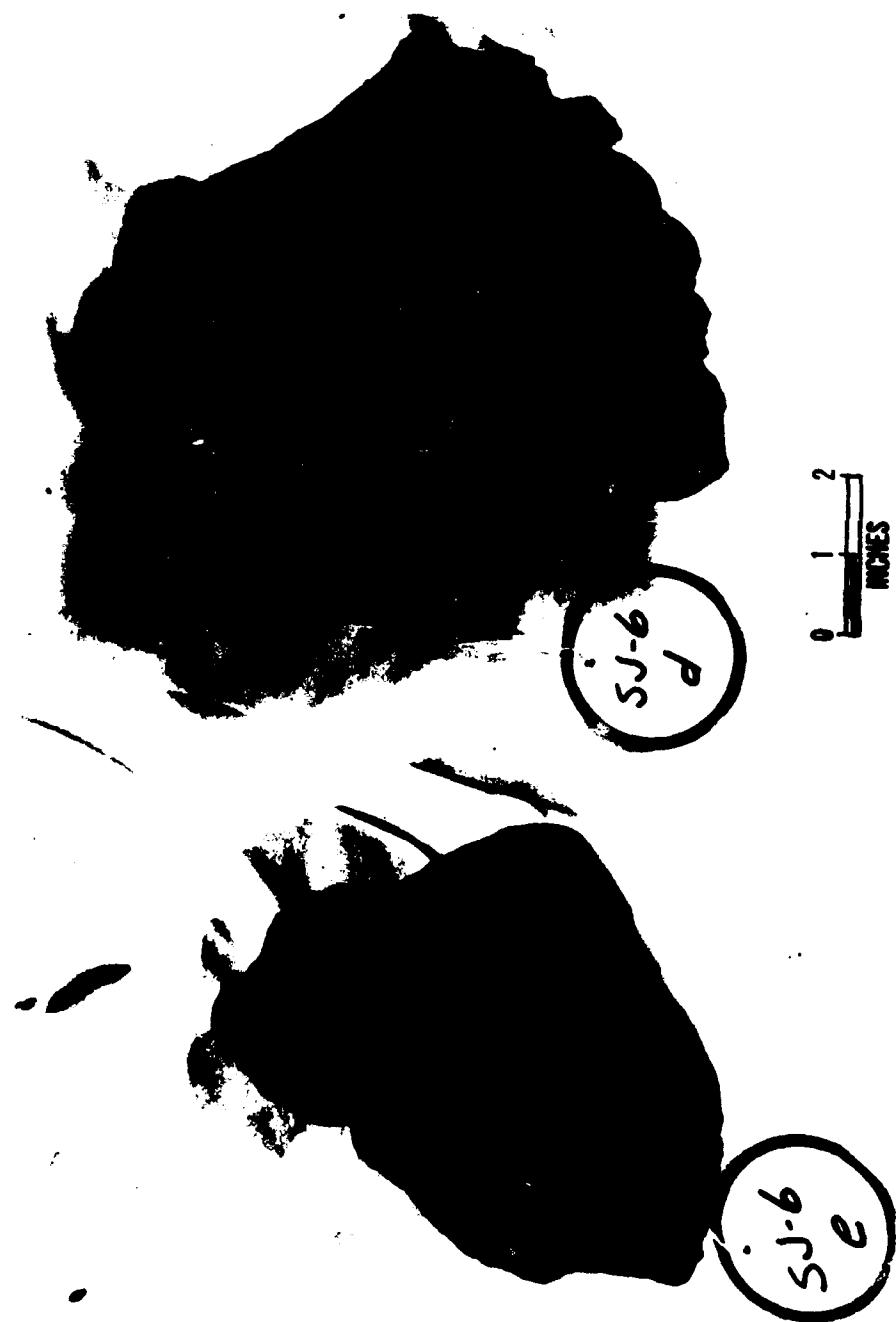


Figure 12. Rocks from San Juan Seamount

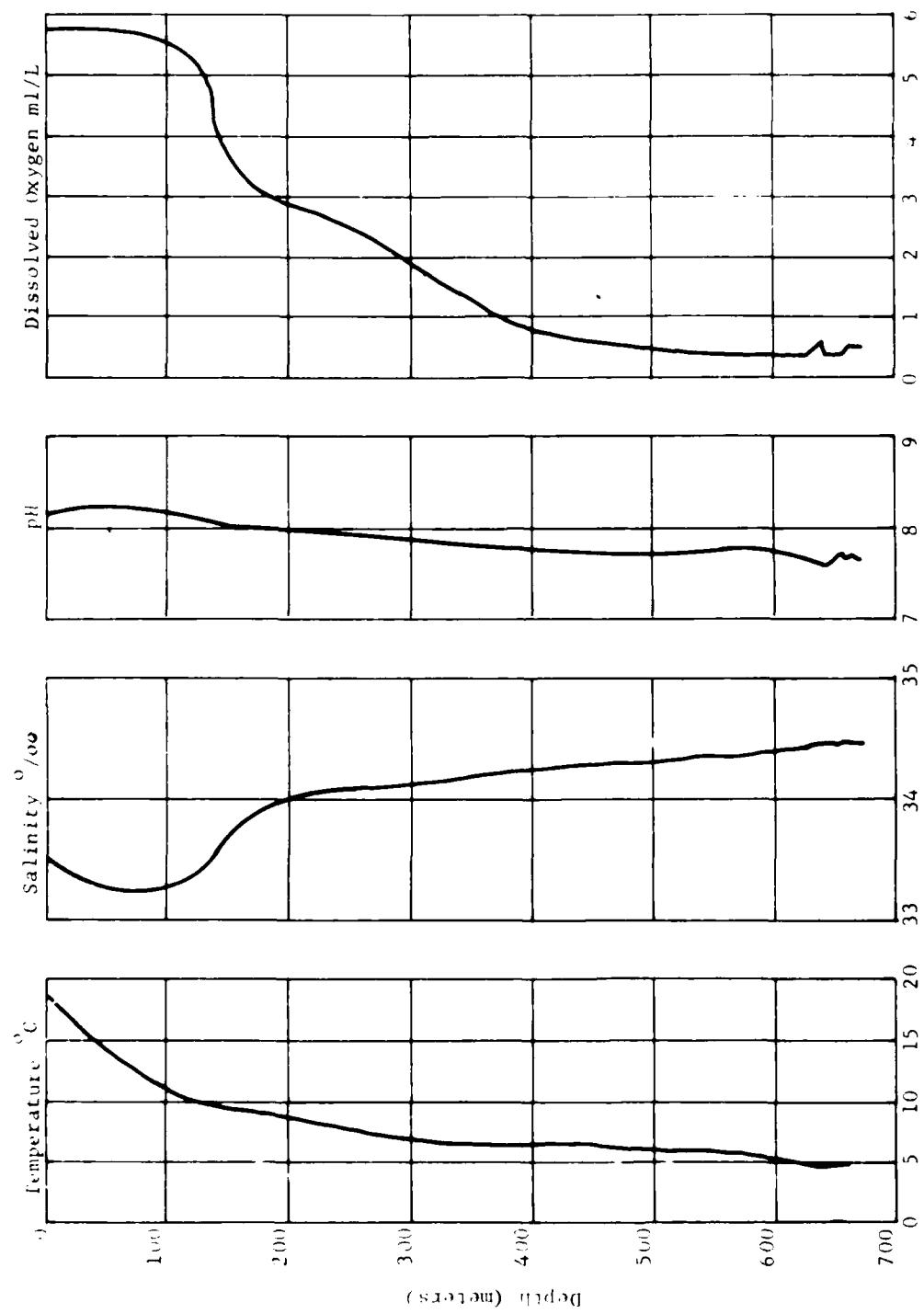


Figure 13. Results of Water Sample Analysis

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	ROLE	WT	ROLE	WT	ROLE	WT
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